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ABSTRACT

The Preprofessional Program's objectives for increasing minority student participation in the health sciences are outlined in this report. Steps taken by the program to meet each of the objectives are briefly described. Data collected during the last year of the program are presented for such areas as class composition, students' career interests, and student achievement. In addition, findings concerned with student evaluations for the entire program period are summarized. A listing of conclusions dealing with the program's successes, failures, and participating students' attitudes is provided. Recommendations are made for selecting students, decreasing dropout rates, and improving the program's effectiveness through tutorial assistance, counseling sessions, special programs, and an increase in minority role models. Appended is a report on the second year of one of the program's course offerings, Physics 101b-103b. (EB)

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FOUR YEAR SUMMARY REPORT

OF THE

PREPROFESSIONAL PROGRAM FOR MINORITY STUDENTS

IN THE HEALTH SCIENCES

UNIVERSITY OF WASHINGTON

By Millie Russell and Edwin Anderson

October 1978

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Dr. Samuel E. Kelly originally opened the door at the University of Washington for the design of this program. We wish to thank him especially, and the following people are thanked for their trouble shooting support and encouragement: first, my right arm, Jack Hatlen, Dr. Jeanne Benoliel, Myrtis Thompson, Frances Solomon, all program teaching assistants, all EOP minority health counselors, the members of the Preprofessional Advisory Committee, Dr. Leonie Piternick, Dr. Lillian McDermott, Mark Rosenquist, the Physics department teaching assistants, Dr. Eric Halsey, Ferdinand Dario, the Instructional Center staff and faculty, and the faculty in Health Sciences. By working together we feel this program has become an important facet in the preprofessional preparation of many minority students.

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Edwin R. Anderson received a Bachelors of Science degree from North Dakota State University in 1965, a Doctorate in Psychology from the University of Washington in 1975, and a Masters in Business Administration from the University of Washington in 1978. His research has focused on the application of learning theory to classroom settings. From 1974 to 1976 he worked as an educational evaluator for the University of Washington Educational Assessment Center. Dr. Anderson is currently employed by General Telephone of the North West as an information systems analyst.

Four Year Summary Report of the Preprofessional Program for Minority Students in Health Sciences

October, 1978

The grant funding the University of Washington Preprofessional Program for Minorities in the Health Sciences is now complete. This report represents the final act in a series of activities that began in 1975.

The report is organized into four major sections: (1) a restatement of grant objectives with a brief description of the program component designed to meet the objective placed immediately after the objective, (2) the presentation of data gathered during the last year of the grant, (3) a summary of the entire period of the grant, and (4) a listing of conclusions and recommendations. The reader interested in additional information describing program components or program results should consult the first, second, and third year evaluations of the preprofessional program (copies may be obtained from Millie Russell, SM-24, University of Washington, Seattle, Washington, 98195). The results of a special physics course for preprofessional minority students can be found in a paper entitled, "Report on Physics 101-103 as Part of the Preprofessional Program for Minority Students in Health Sciences," and in Appendix A of this report. Requests for information not contained in reports should be directed to Millie Russell, program director.

1. Preprofessional Program Objectives and the Steps Taken to Meet Them

Objective A: Increase the pool of qualified minority students interested in entering the health sciences through an integrated program seeking to assist students to:

1. develop reading, study and conceptual skills required to master science courses;

2. gather information about the health sciences and establish career goals;

3. identify obstacles to success in the health sciences area chosen; and

4. cope with personal and academic problems.

Subobjectives 1 and 2 were met with a three quarter course sequence, General Interdisciplinary Studies (GIS) 140, 141, and 142. The first two quarters of the sequence feature lessons in reading and study skills with application of the skills to health related learning material. Medical vocabulary and career awareness were emphasized. Speakers from the various health professions, members of minority groups themselves when possible, attended class to give students a closer look at what they do as health professionals. Additional emphasis on reading and study skills was provided through the Economic Opportunity Program Study Skills Center. Direct experience with specific health professions of interest to the students was given through field contact with working professionals in the spring quarter of the GIS sequence.

Identification of obstacles, subobjective 3, involved contacting instructors and supervisors from health sciences programs and asking them where students who fail or are marginally successful in their programs have their trouble. Preprofessional students were then told what preparatory courses they might take to increase their probability of getting past the trouble spots in their chosen program.

Coping assistance for personal and academic problems was given through quarterly counseling sessions with program staff. Assistance took the form of advice, moral support, encouragement, referral, etc.

Objective B: Increase the numbers of students enrolled in the program to 60 and to evaluate an increase in class size from ten to fifteen.

The grant supporting the preprofessional program extended a pilot project with ten students. The increase in students did occur; there were 54 students the first grant year, 69 the second, and 51 the third.

Class size was extended to roughly thirty as teaching four sections of approximately fifteen students each proved unwieldy.

Objective C: Offer the program to second year students as well as first year students.

The class sections mentioned in B divided into one of first year students and one of second year students.

Objective D: Evaluate the preprofessional students with respect to:

1. general progress in the University and in the preprofessional program;
2. success in entering their chosen health career; and
3. progress in the health profession studies after admittance.

To accomplish this objective, we collected transcripts for all preprofessional program students for comparison with grade information collected by the campus educational assessment center in a study of EOP students across the entire campus. We also contacted all students connected with the preprofessional program to determine health science application success. Additionally, information was collected concerning school withdrawals and changes of career interest. Unfortunately, progress in professional studies after admittance cannot be measured--the preprofessional program hasn't been operating long enough to have its graduates in professional programs in numbers large enough to draw conclusions about success.

Objective E: Draw the health science faculties into the program to develop their appreciation of the problems encountered by minority students

The primary means of establishing faculty-minority student contact was the spring quarter field experience contained in GIS 142. Each program student was assigned to faculty practicing in their area of interest. The students followed on rounds, observed day to day job performance, performed simple tasks, and received tutoring and counseling by the faculty mentor. Students kept journals of the experience, which the faculty members later read. The faculty members turned in evaluations of the students, and in some cases, included letters of recommendation for use in later admission attempts.

Objective F: Develop learning resource materials to illustrate the use of conceptual and mathematical tools in solving health science problems.

Several preparatory science and mathematics courses had their content altered to reflect problems found in health sciences studies. Biology 103 was more heavily oriented toward human biology and the techniques associated with human research, mathematics courses leading to college algebra were adjusted to include the proportion problems associated with nursing, and physics 101, 102 and 103 were designed around Piagetian theories about the development of formal reasoning in an effort to produce better analytical ability in the preprofessional students. These courses required the students to articulate the reasoning processes behind the conclusions they drew. The 1977-1978 physics course results are described in Appendix A.

Objective G: Promote the interests of minority students in health sciences settings outside the specific boundaries of the preprofessional program.

This objective was not stated on the grant request, but the visibility and position of the preprofessional program within the U. of W. health programs made it a natural and desirable extension of our effort. We believe objective G is implicit in many of the efforts of the preprofessional director; the objective deserves explicit recognition. We have selected the term Outreach as a summary of activities directed at this goal. The outreach activities are as follows:

1. By periodic guest appearances at local schools, program faculty and students have been involved in minority recruitment at the middle school, high school and community college level.

2. Conversations with faculty teaching mathematics, physics, biology, chemistry, and nursing have given essential information for course sequencing and at times have led to new course content to meet student needs.

3. Non-GIS, as well as GIS students in health sciences, are being academically counseled by program director. Many non-GIS students drop in to "rap" about career direction and to apply to summer science programs.

4. The present Nursing Tutorial Program was born out of a volunteer tutorial project organized through our program to serve nine minority students in Conjoint (anatomy and physiology). As a result, all tutored students passed Conjoint. Seven are now graduate nurses.

5. The Minority Affairs Committee of the School of Dentistry was organized by our program director at the request of the Dean of the School

of Dentistry. Two minority dental students received four-year scholarships for tuition and books from this committee. At this time, they are entering their third year. Also, one minority faculty person was hired in the dental school as Assistant Dean of Student Affairs. All minority dental students now use this committee as support to resolve problems.

6. At present the program director influences curriculum for minority students through representation on the advisory boards of two high schools, two community colleges and one four-year college. Evaluation reports and program materials are shared with regional and nationwide programs.

7. To date, six minority pre-medical and pre-dental students have attended Summer Sciences Programs nationwide as the result of program outreach.

8. This year additional federal funding was obtained and earmarked for broadened tutorial support of minority students in all health professional schools, and for the position of an overall minority health coordinator as an associate professor.

2. Analysis of Data Collected During the 1977-1978 Academic Year

1977-1978 Class Composition: GIS class structure is shown in the following table, and a categorization of the students' career interests immediately follows the table.

1977-1978 GIS Class Composition

	American Indian	Asian	Black	Chicano	White	Total
GIS 140A						
Female	1	3	16	8	-	28
Male	-	-	1	3	-	4
	1	3	17	11	-	32
GIS 140B						
Female	-	1	8	-	1	10
Male	-	-	4	3	2	9
	-	1	12	3	3	19

Career Interests

Field	# of Students
Medicine	18
Nursing	14
Dentistry	6
Dental Hygiene	2
Pharmacy	2
Physical Therapy	1
Occupational Therapy	2
Health Administration	1
Health Education	2
Psychology/Social Work	1
Undecided	2
	51

Evidence of Health Sciences Information Gain. The GIS sequence includes the provision of health sciences information to minority students as one of its major goals. Two measures are particularly indicative of program success in meeting this goal: (1) a career awareness test and (2) a health vocabulary test. Both measures consist of recall given in response to key words. In the health careers test, students were asked what they knew about listed health career specialists, e.g., dermatologists, podiatrist, pharmacist, internist, etc. Responses were scaled on a 100 point basis. A comparison of before instruction and after instruction administration of the same test shows clear learning gains (pre-test mean = 47.8, standard deviation = 18.74; post-test mean = 80.47, standard deviation = 20.19; N = 30). The pre-test was given at the beginning of the Fall quarter while the post-test was given at the end of the Spring quarter, students did not study specifically for either test. The health vocabulary test asked students to define the words on a list of 50 health sciences terms, e.g., mutation, morbidity, leukemia, pathology, etc. Pre-test and post-test differences were again substantial (pre-test mean = 23.25, standard deviation = 17.33; post-test mean = 85.62, standard deviation = 20.93; N = 29).

A second kind of evidence points to accomplishment of the information spreading goal. The Spring quarter GIS course has program students observing faculty in their area of health sciences interest. The students wrote a journal describing their field experience. Reading the journals revealed a free and correct usage of medical terms as well as increased knowledge of the profession observed. In addition, nearly every journal writer closed with enthusiastic praise for the field experience along with expressions of renewed interest in becoming a health sciences professional.

Unfortunately, a note of caution must be placed here. While individual health science terms were used appropriately, many of the journals were badly written, i.e., there were frequent syntax errors, noticeable weakness in organization, and imprecise use of normal vocabulary. Unquestionable differences in writing quality occurred between the best and the worst of these journals. There was, as a result, a tendency on the part of the teaching assistants doing the grading to let better papers slide by uncommented. The authors have experienced this same grading phenomenon in other university classes. Although syntax and expression were good, weaknesses in organization, perhaps the hardest writing error to comment upon, were apparent in many of the better papers. In a program of this type, however, "A" papers should be graded with stiffer standards because the real competitors are not other minority students but rather students from the university at large who compete for entry into health sciences programs.

Many additional exercises given in the GIS course sequence support the examples given above. The preprofessional program students are accumulating information about the health sciences which is of value and interest to them.

Traditional Measures. Most universities use high school grade point average (GPA) and entrance test scores as major components of admissions policy. The University of Washington places heavy emphasis on the Washington Pre-College Test (WPCT) in particular. Most preprofessional students have not taken the WPCT; the following data comes from a subset of fifteen students who did.

Like most entrance tests, the WPCT produces estimates of verbal and quantitative ability. The means of the fifteen students with complete

data sets are 38.7 and 39.6 respectively. These figures compare to University of Washington entering freshmen means of 55 for the verbal composite and 56 for the quantitative composite; the GIS students fall below the lower 10th percentile on this measure. Correlations between WPCT scores and U.W. GPA are considerably higher than those reported in the third year evaluation (Pearson product moment correlation (r) = .64 between the quantitative composite and GPA, and r = .46 between the verbal composite and GPA; last year r verbal vs GPA = .18 and r quantitative vs GPA = .31).

For these same students, high school GPA and college GPA showed a .59 correlation. This years correlations are close to the correlations found in large scale studies predicting academic performance. The small size of the sample WPCT scores does suggest a cautious interpretation.

The cumulative University of Washington GPA's for students associated with the preprofessional program, present and past, were collected from student transcripts. As with the WPCT data, the samples are not complete although they are more nearly complete in this case. Table 1 shows the average GPA by year.

Table 1

Cumulative GPA for Present and Former GIS Students

Year	Sample Size	GPA	Stan. Dev.
1975-1976	46	2.25	.58
1976-1977	53	2.44	.63
1977-1978	43	2.36	.86

A complete study of transcripts for all students (2,615) enrolled in the U. of W. Educational Opportunity Program from 1969 through 1973 showed the average GPA for these students to be 2.2 (Hodgson & Lutz, 1975). Approximately ninety percent of these students enroll in Arts and Sciences (A & S) departments. Non-A&S EOP students showed a GPA of 2.5. These data, in conjunction with the preprofessional GPA's, do not provide any reason to believe the preprofessional program has lead to grade improvements among participating students.

Rating Forms. The GIS course sequence was evaluated through two student ratings forms: the all university student ratings and a form prepared by the GIS instructor. The university rating system publishes percentile comparisons of individual courses with university norms. On questions directed toward course organization and content the GIS ratings fell primarily in the 40 to 70 percentile range. Questions related to instructor enthusiasm and concern for student learning were given ratings in the 80 to 100 percentile range. The ratings indicate student recognition of the genuine concern with their progress shown by the pre-professional staff. The second rating form, written by the program director, asked questions about GIS class helpfulness and the availability and use of the study skills center. The students unanimously agreed the class was helpful. Reactions to the study skills service were mixed; many of the students felt they did not need the service and, consequently, did not use it.

Two additional points based on the student ratings are worth mention. First, there is a notable similarity in the student responses from year to year, each group of students sees the GIS courses much the same. Surveys made in later years thus did not yield worthwhile information about the program. Our experience with other university courses leads us to believe this to be a general finding. Programs using student ratings would be well advised to change their rating forms with each new class. We also suggest the possibility of splitting classes into two or more groups and giving different rating forms to each group. These two steps will increase the value of ratings information. The second point deserving mention has to do with open ended comments. The university forms have a sheet with a general question asking for a course's good features. A majority of the students cited the professional speakers program in response to this question. Uncued mention of the same course feature by many students is rare on these forms, and so we conclude that the students highly value the speakers program.

Faculty tutoring students during the Spring field experience were sent a form requesting evaluation of the assigned students. The open ended form asked for statement of career interest, attendance, and performance along with a request for general comments. Many of the responses

were quite detailed. Of particular interest were a few forms that contained negative evaluations, with supporting reasons, of students. Requests of this type often yield only positive responses, but apparently the tradition of honest evaluation required in the medical profession counteracted what might be termed "the polite evaluation" in which weak performers are lightly praised. The positive statements made with respect to a majority of the students gain credibility from critical statements made about nonperformers. Several of the faculty included letters of recommendation with their evaluations. Several faculty members also explicitly asked to be assigned students again. These responses in conjunction with favorable student reactions to the field experience lend support to our belief that the objective of establishing contact between health sciences faculty and minority students is being adequately met.

Program Success in Providing a Pool of Minority Students for the Health Sciences. The staff of the preprofessional program attempted to survey all students who had passed through the program during the 1975-1976 and 1976-1977 school years to determine their present status. There were 54 students beginning the 1975-1976 GIS sequence; of these, 46 were contacted by the survey. Fourteen students have withdrawn from school; five more are not in school but plan to return. An additional eight students have applied for health sciences programs; nine of the ten students were accepted—four entered nursing, two entered health education, and one student went to each of the following: medical technology, social welfare, and environmental health. Nine students have expressed continued interest in the health sciences, and may yet apply. Only three students in this group have GPA's approaching the 2.89 average of the 10 original applicants.

The survey contacted 49 of the 69 students entering the 1976-1977 GIS sequence. Nine are no longer in school, and six more have lost interest in the health sciences. Nine have applied for health sciences programs; six have been accepted (average GPA = 2.67). Acceptances were given in nursing (2), pharmacy (1), health education (2), and social work (1). The 25 remaining students are still potential applicants for health sciences programs.

3. Summary of Grant Findings

Looking over the data generated over the past three years makes it apparent that the data gathered are quite stable from year to year. For instance, the mean Washington Pre-College Test scores for the last three years are 41.9, 41.4, and 38.7 on the verbal score and 44.5, 43.7, and 39.6 on the quantitative score. Grade point average for the three classes were 2.25, 2.44. and 2.36. Looking at student evaluations makes it clear that the pattern of responses to questions remains consistent from year to year, i.e., questions given low ratings one year stay low the next and questions rated high stay high. Health vocabulary scores on pre-test and post-test measures are nearly identical for the last two years; the current gain in vocabulary scores was 62.4 points while the gain a year ago was 59.5 points. The same regularity was found in the health careers results. Evidence gathered in other University of Washington evaluations (Anderson, 1975a, 1975b, 1976) points strongly to the conclusion that measurement reliability is a generalizable feature of academic programs. Once a measurement has been made within a program, there is little new information to be expected from repeating the measure with a subsequent class. The effort of measurement would be better directed at finding different information.

Post hoc attempts to distinguish successful students from unsuccessful students with measures collected before classifying the students did not work well. Non-predictive measures included a standardized biology test, a standardized general sciences test, the Survey of Study Habits and Attitudes, and reading scores from a locally prepared test. Correlations between these measures and performance, while positive, were low (i.e., generally less than .25). The 1977-1978 WPCT scores showed normal correlations with GPA (verbal by GPA = .46 and quantitative by GPA = .64), however, those same correlations were much lower the year before. The WPCT correlations were the one case of nonstable measurement found in our data. A mathematics test prepared locally showed consistent, although week, ability to predict successful students on a post hoc basis. The test would not prove to be of much use for performance prediction in advance.

The GIS students show clear learning gains over their year in the program. Knowledge of health careers and health vocabulary is substantially

greater after the program; both immediate gains and long term retention are good. There are small, but steady, gains in mathematics and physics.

Finally, all of the people who participate in the program have evaluated it favorably. Student comments, solicited through student ratings, have generally been positive with field experience and the health professional speakers program receiving special mention. The medical faculty serving as mentors for the field experience have responded with praise for many of the preprofessional students and with offers to accept students in the future. The preprofessional staff has continued to believe that the service they offer to minorities in the health sciences is a valuable one.

4. Conclusions and Recommendations

4a. Our overall evaluation of the preprofessional program is a favorable one. Several program goals are being met: students do learn about health sciences careers, small gains are being made in physics and mathematics knowledge, health sciences faculty are brought into favorable contact with minority students, the program has increased the number of students handled, and Outreach has helped promote minority interests in the health science setting. On the other hand, the effort expended to improve the reasoning ability of GIS students through special mathematics and physics sections has a tendency to overshadow the gains. The overall effort to help students has left university GPA's unaffected. Despite attempts to counsel students, the problems they have to face often prove to be too much. The proportion of students withdrawing from the program is high; the withdrawals lead to an ambivalent response on the part of the staff--disappointment that so many students leave and pride that 20% to 30% of the students stay in the health sciences when they might not have stayed if there were no program. Clearly the need for minority programs like the preprofessional program continues. And while the program is not 100% successful, it should be borne in mind that attempts to improve student learning are rarely an unqualified success (Anderson, 1976b).

4b. The students, when asked their health science interest at the beginning of the GIS sequence, invariably give heavy favoritism to medicine,

dentistry and nursing. These fields typically are selected in 75% of the responses. A look at the 15 students from the preprofessional program already accepted in health fields shows six have entered nursing, four are in health education, two are in social work, and one each is found in environmental health, medical technology, and pharmacy--a distribution that would not have been predicted from their original statements of interest. We feel that the preprofessional program is opening alternatives not in the student's minds initially, but which will help them satisfy the values which brought them to the program. Medicine and dentistry, while attainable professions by a few of the GIS students, are not realistic choices for most of them. Admittedly, such a conclusion is premature since most of the students haven't had time to complete pre-med or pre-dentistry preparation, but it seems unlikely that more than a very few of the GIS students will follow such a path. There has been no effort to quash aspirations, nevertheless we feel the rechanneling of interests to be a preprofessional program strength.

4c. A university registrar uses high school GPA and college entrance tests as a means of selecting students who will prove successful in his school. The selection procedure does, on the average, work even though some students who are let in fail and some students who were left out would have succeeded. In programs like the preprofessional program, the pool of applicants has already been admitted to school. Further selection via testing is not advisable. A more useful alternative is to let all applicants enter the program and then let self-selection reduce the number of students in the program. Many students shift interest to other fields when given accurate career information, some students drop early for academic reasons, and some students drop for personal reasons. The remaining students will be a better selection for the program than any existing tests could make. If there are too many applicants to permit this approach, then we recommend traditional selection through high school GPA and entrance tests--our attempt to provide other means of selection did not yield an improvement over them.

4d. Students seriously interested in medicine, dentistry, and allied health should be required to take a scholastic aptitude test early in their schooling. Low scorers on entrance tests, e.g., the Washington Pre-College

Test, should be advised that they will probably score low on the MCAT, DAT and allied health tests as well. Test expenses should be paid for with specially budgeted funds and justified on the grounds of program effectiveness as many of the students can't afford to pay for them.

4e. Faculty authored pretests should guide student course selections. Without pretests students should begin at the lowest level available to build an adequate body of knowledge and self-confidence. Ideally, academic counselors of health sciences students would be science majors and perceptive, knowledgeable curriculum planners. Students are all too often encouraged to take courses beyond their present abilities. Closer attention to proper preparatory courses could have prevented many disastrous encounters with difficult mathematics, physics and chemistry courses.

4f. In our three quarter GIS classes only students earning credit in GIS 140 and performing at a high level while doing so should be promoted to GIS 141. Only students earning credit promptly and performing at the desirable level should be promoted from GIS 141 to GIS 142. This would prevent the non-serious student from participating in Spring field experience and thus ensure enthusiastic faculty support.

4g. In order to reward student performance while at the same time continuously motivating students to achieve, it would be wise to make GIS 141 and 142 graded classes. The Autumn quarter should remain on a credit - no credit basis to allow students initial exploration with no penalties for disinterested performance.

4h. GIS students attend mandatory tutorial and study skills sessions when they take an english, science, or mathematics course. Mandatory attendance familiarizes all students with support services and prevents the problem of students coming in too late because of negative feelings about needing help. The attendance requirement is dropped for those students who are successfully handling the course work. We feel this practice has been successful in reaching students needing help, and recommend continuing the practice.

4i. In the GIS classes students were required to participate in one brief counseling session each quarter with one staff person. This practice quickly established rapport with students unaccustomed to personalized attention. The program director maintained a 24 hour a day open door policy.

and many important interactions with students occurred outside of "normal" hours of operation. Staff in a program of this type should be very conscious of their accessibility to students.

4j. A preprofessional summer program should be developed to serve first, northwest regional preprofessional minority students and second, to accomodate a minority exchange nationwide. This would broaden selected students backgrounds for professional careers, academically and emotionally.

4k. Minority students will continue to enter into post secondary baccalaureate education inadequately prepared by high school for the rigor of preprofessional science curricula. Therefore, special programs such as this one need to cease their "special" status and become structurally a part of the university.

4l. An overall lack of role models threatens minority student ability to cope with the middle class campus community and encourages self-doubt in the minority student by provoking the question, "Am I qualified to be here?" Therefore, it is important to maintain a cohesive program that periodically links minority students to minority role models in professional health careers. The favorable reaction of the students to the minority speakers program lends credence to this view.

Appendix A

REPORT OF THE SECOND YEAR OF PHYSICS 101B - 103B

AS PART OF THE

PRE-PROFESSIONAL PROGRAM FOR MINORITY STUDENTS IN HEALTH SCIENCES

Prepared by: Dr. L. C. McDermott and
M. Rosenquist
September, 1978

The physical sciences are a source of great difficulty for academically disadvantaged students who aspire to careers in the health sciences. Some preprofessional programs require a course in physics, and all require some physical science. Since many of the most basic concepts (such as mass, volume, density, velocity, etc.) used in all physical sciences are the subject matter of physics, a physics course which addresses the needs of such students can play a vital role in the development of concepts and skills necessary to succeed in pre-professional programs in the health sciences.

In 1976-77, and again in 1977-78, such a course has been offered by the Physics Department under the name Physics 101, 102, 103 as a part of the PPMSHS. The course contains two main features: 1) direct experience with basic concepts through many concrete, hands-on experiments, and 2) development of the students' scientific reasoning skills through insistence that all reasoning be clearly and consciously explained in detail. The course is taught by the inquiry method. There are no formal lectures; rather, the students work on experiments and problems in the lab while the instructional staff engages individual students or small groups of students in dialogs concerning the subject matter. We believe this to be the best known instructional method for developing concepts, reasoning, and self confidence. A large staff is required, but such an investment is necessary for students who lack, as ours did, sufficient self-confidence and direction to be more independent. Although such close attention is irritating to some students at first, on an end-of-course questionnaire, our students overwhelmingly preferred this method to lecture and separate lab. Many indicated that they found the close attention supportive.

We have now offered this course for two years. A report of the first year's course (1976-77) was prepared in September 1977, describing the topics covered and the skills stressed in the course.* The 1977-78 course was similar to the first, but with some modifications made in light of the first year's experience. The purpose of the descriptions given here is not to reiterate the general plan of the course but only to report on changes made during the second year and to suggest future modifications.

* Report on Physics 101 - 103 as part of the Preprofessional Program for Minority Students in Health Sciences, September 21, 1977

Concepts

One of the most serious problems facing many of our students is the lack of sound understanding of basic physical concepts, especially the ability to apply the correct concepts to physical situations. University science instructors usually assume students are familiar with basic concepts such as mass, volume, velocity, etc., from their earlier education. Two years experience, however, has indicated to us that our students lack the previous experience they must have if they are to apply and build upon basic physical concepts. For this reason, work on basic concepts has become an important part of the course.

During the second year, we have made a concerted effort to guide students toward an understanding of various concepts. We have found that a persistent problem for many students is the confusion of two concepts which might apply to the same physical situation, for example: mass and volume, position and speed, heat and temperature.

We feel that the course has been largely successful in enabling students to resolve such concept confusion. The following table represents our assessment of the students' progress in separation of a sample of concepts.

	PERCENT MAKING CONFUSION	
Concept Pairs	Before Instruction	After Instruction
Mass and Volume	50%	10%
Position and Speed	50%	10%
Velocity and Acceleration	95%	50%
Heat and Temperature	100%	35%

Figures apply to students who finished three full quarters.

It should be stressed that the difficulties involved in forming and correctly applying concepts are frequently subtle and persistent. While students may quickly memorize verbal definitions and descriptions of concepts, confusion over how concepts should be applied in actual situations may persist for weeks or months while the students gain the experience necessary for a useful working understanding.

Reasoning

One of the significant results of the first year's course was a dramatic improvement in the students' ability to reason quantitatively by the 21st week.

Before the second year began, the program in quantitative reasoning was revised in light of the experience of the first year. During the second year, only 35% of the students who finished two quarters of the course showed evidence of quantitative reasoning ability at the 6th week of the course. By the 15th week, however, 90% showed quantitative reasoning ability. Thus the quantitative reasoning program continues to be effective, and a saving of six weeks has been achieved. The time saved is important, as it allows the students six more weeks to practice applying their reasoning skills. We consider such continued practice essential to retention in future courses of quantitative reasoning skills and the accompanying self confidence.

In addition, the extra time afforded has allowed us to progress to more sophisticated reasoning involving proportions among three variables (heat, mass, and temperature change) in the study of heat. At the end of three quarters, 50% of the class demonstrated entirely adequate reasoning ability in this context.

Skills

In addition to understanding concepts and being able to reason, students must have various academic skills in order to benefit fully from their courses and to communicate to others what they have learned. Writing, interpretation of graphs, and use of algebra are skills which are essential to success in the health sciences; but many of our students initially do not have the proficiency in these skills which is required in preprofessional programs. In Physics 101-103, as in other elements of the PPMSHS, we give the students many opportunities to practice and develop such skills.

The manner in which writing is handled in our course is described in the 1976-77 report. There have been no essential changes in the second year.

Graphic and algebraic representation of relationships are commonly used in all science courses. To a great extent, they constitute the language of science. During the second year, there have been several significant changes in our treatment of these representation skills which

should be described.

The program in graph interpretation used in the first year's course was quite successful in teaching students to use graphs in connection with the physical concepts studied in class, especially in the case of straight line graphs. During the second year, our program in graphs has been extended. The interpretation of curved graphs has been given more stress, and the students were given practice in interpreting graphs of quantities they had not studied previously. At the end of the course 60% could correctly interpret a curved graph, and 50% could transfer their skills to a graph concerning new material (for example, animal growth rate). The corresponding figures for the beginning of the course are essentially 0% and 0%.

In the second year we initiated a program in algebraic representation. Though many students had memorized the rules for manipulating algebraic equations once given the equations, most were unable to write down an equation to describe a physical situation or to interpret the meaning of an equation in terms of physical concepts or laws. These aspects of algebra with which the students have difficulty are exactly the aspects of algebra which are most important in following a derivation in lecture or solving an examination problem in a typical science lecture class. We devoted several lessons and activities to this topic over the span of one month. During this time, the fraction of students showing ability to apply algebra to linear relationships increased from 25% to 50%.

In our first attempt to work with algebraic representations, we underestimated the severe difficulty students have in connecting algebraic expressions and the real world. The students made considerable progress, but not as much as we feel they could have if given more time. We expect that we will do much better next year when we plan to devote more time to this skill.

Student Attitudes

It remains our feeling that among the course's most important and lasting benefits to the students are its effect on the students' attitudes toward science and its effect on the students' self-confidence. Because the first year's course was successful in these regards, we continued in a very similar manner in the second year. Last year's report described changes in the students' attitudes, but some remarks on the nature of our approach to building self-confidence bear mention.

In the first weeks of class, it is apparent that most of the students are frightened of the subject matter, especially its quantitative aspects. Nearly all of the students behave as if they have little confidence in their abilities to handle the course work. This is particularly evident when students are asked to explain their reasoning. Many are reluctant to even try, often saying in effect, "I can't". They have apparently never before been seriously asked to engage in this type of thinking. However, with individual attention from the staff, nearly all can be coaxed through the process of explaining reasoning. When a student does eventually reason through a problem on his own, the result is invariably a real sense of accomplishment and increased motivation.

Care has been taken to plan curriculum so that the students are posed problems which have two important characteristics. First, the problems must require detailed explanation of the reasoning involved. Second, the students must be able to succeed in solving the problem after putting forth a respectable amount of effort. We attribute much of the increase in self confidence to instruction of this sort.

General remarks

1. One unfortunate reality is that many of the students who start the course do not finish. There are many reasons why a student may not finish the course. Some reasons are beyond the student's control. A student may become ill or may simply not be able to handle the material even with extensive help. For these students we can do nothing.

In other cases, however, students may lose the desire to continue the course for reasons which can often be outweighed by support from the staff. For example, some students, because they have never been expected to reason and understand, do not see the value in explaining reasoning or going beyond memorized definitions of concepts. Others feel the course is too difficult because it requires much more work than has been asked of them before, and they become discouraged. Some students feel they are wasting their time because they already have a superficial grasp of the material, though they lack the depth of understanding required in professional programs.

In each of these cases, most students can be convinced to remain in the course if given support, encouragement, and explanations of why they will need what the course offers. In providing this support, the cooperation between the staffs of Physics 101-103, GIS 140-142, and Biology 103 is of essential

importance. The effect of this coöperation can be seen in the attrition figures for the 1977-78 physics course: students who were also in GIS 140-142 were twice as likely to finish the physics course as students not in the GIS class. These figures provide evidence that an integrated program such as the PPMSHS is far more effective than the separate efforts of different departments in preparing academically disadvantaged students for professional programs.

2. Having had two years experience with the physics course, we are now in the position to suggest a plan for admitting and retaining students. This plan is based on two conclusions drawn from experience. First, it is not possible to distinguish students with insufficient ability from students with ability but poor background solely on the basis of tests. Second, there are some students who are beyond our help, and these can be identified after about one month.

Because it is not possible to pre-select successful students, a large number of students must be admitted in order to retain a reasonable number of promising students. Since the physics course gives individualized instruction, however, the students beyond our help can use valuable staff time which is needed by students with potential. Last year we feel we could have retained more of the promising students if we had had more time to spend with them. Our suggested plan, then, is that we admit a large number of students, say 70, and then after one month, channel the students beyond our help out of the class, thus reducing the enrollment to about 45 students. We anticipate retaining about 30 promising students under this scheme.

3. Several pre-professional programs require a standard introductory physics course, usually Physics 114, 115, 116. This is a difficult course even for students with strong backgrounds. For the students in our class, it provides a major obstacle to admission to competitive professional programs.

We are now beginning to form a picture of what is required for a student to do well in Physics 114. Most important, it is essential that the student complete Physics 103 before beginning Physics 114, as Physics 103 is devoted almost entirely to material covered in Physics 114. We have now had about ten students who have attempted Physics 114 without having taken Physics 103 or while taking Physics 103 concurrently. Most of t ese were quite able students, yet none has received a grade of 3.0 (B) or higher in Physics 114.

This year three of our students took Physic 114 and did very well, receiving grades of 3.8 each. We watched with great interest the progress of these students and have noted several ingredients which we believe contributed to their success. These students all worked hard in Physics 103, explaining their reasoning thoughtfully and spending considerable time on challenging homework problems. Considerable time spent on homework is one of the keys to success in Physics 114, and our successful students continued the necessary study habits over from Physics 103. Most of our students initially have no conception of the amount and kind of work which is required in their science courses, and essentially none are practiced in this type of study. The Physics 101-103 sequence gradually builds homework assignments in length and difficulty in an attempt to develop the necessary kind of study habits. Our three successful students, we believe, were prepared for the work load in Physics 114 in part as a result of following the progression of the work load in Physics 101-103.

One of the advantages of having been a student in Physics 101-103 is that the student comes to know several physics instructors who can be called upon for help in later courses. The three students who did so well in Physics 114 frequently sought help from the Physics 103 staff with the material in Physics 114, both in special sessions before the course started and throughout the course. Other students from our class who took Physics 114 but did not come in for help did not do better than 3.0.

The success of three of our students indicates that strong performance in Physics 114 is a reasonable goal for able students in the PPMSHS. We can also conclude that the conditions which lead to success in Physics 114 seem to be receptiveness to the type of topics and skills stressed in Physics 101-103, hard work in Physics 103 before taking Physics 114, and extra help while taking Physics 114.

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